SHEAR-INDUCED MIGRATION OF POLYMERIC HEPARIN-ADSORBING PARTICLES IN A LIQUID-FLUIDISED BED

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Introduction

Systemic heparinisation of haemodialysis patient's blood enhances the risk of hemorrhagic complication. In previous communications a heparin-adsorbing device (H-AD), which constitutes an extracorporeal circuit that allows ex vivo selective de-heparinisation (~90% of heparin) by means of a poly-cationic ligand grafted on polymeric beads [Podias, Missirlis, 1997; 2003a; 2003b] was described. The present work introduces a computational fluid dynamics (CFD) based multiphase mixture model as a tool to support engineering design and research in multiphase systems such as fluidised beds.

Methods

A multiphase mixture model of a sheared, dense suspension of polymeric microparticles in whole blood, discretised via a finite element method (FEM) based formulation, is reported in the present work. It accounts for not only buoyancy effects, but also shear-induced migration, that is: the tendency of particles to migrate toward regions of lower shear rates. Particle migration results from gradients in the shear rate, concentration and relative suspension viscosity. The transfer of forces between the liquid and particle phases is described elsewhere [Di Felice, 1994; Podias, Missirlis, 1997; 2006].

Results and Discussion

The spatiotemporal evolution of bed expansion, solid particles' velocities, and local flow field are depicted in fig. 1. Particles in an initially packed bed configuration (t = 0) are lifted by the flow; then migrate to the low shear-rate region (fig. 1). The expansion bed height is given in fig. 2 that also shows the profile of volume fraction of particles along bed height for different superficial whole blood velocities. The volume fraction of polymeric particles decreases quickly near the inlet, and is constant within the bed. Additionally, it drops and approaches to zero at the bed surface.

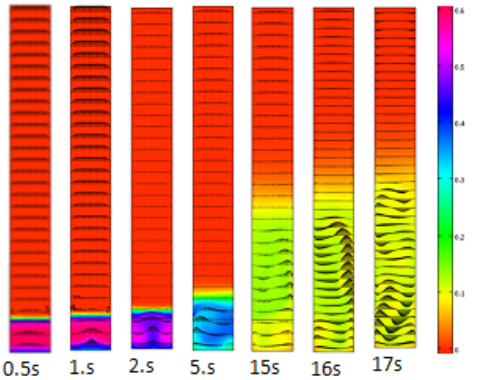

Figure 1: Temporal evolution of bed expansion in terms of the distribution of the volume fraction of the dispersed phase (0.5-17 seconds). Particles' velocity field is depicted with black arrows.

The volume fraction of the dispersed phase decreases with an increase in superficial velocity, whereas the bed height increases.

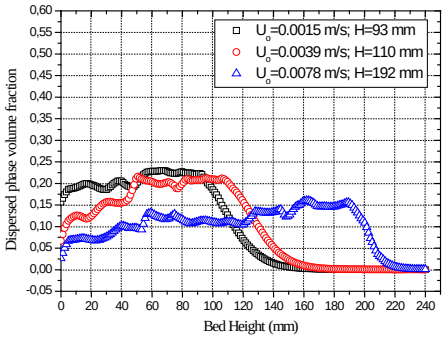

Figure 2: Distribution of the volume fraction of the dispersed phase along bed height.

References

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